Take-Away Notes from ISECG Science White Paper discussion at ELS 2015

ISECG participating agencies leveraged the opportunity of the European Lunar Symposium (ELS) 2015 in Frascati, Italy, to discuss the Global Exploration Roadmap and the science opportunities of early mission themes with the scientists present.

The current work progress on the next iteration of the Global Exploration Roadmap, currently envisaged for publication in the summer 2016 timeframe, was presented together with some insights into ongoing work on details of the early mission themes:

1. Extended duration missions to a cis-lunar habitat
2. Human exploration of a Near-Earth Asteroid in cis-lunar space
3. Human lunar surface exploration

ISECG agencies have engaged in an interactive process with the scientific communities to develop a Science White Paper as a companion document to the next version of the GER, highlighting overarching science topics of exploration science and describing the scientific opportunities of the early GER mission themes.

Feedback and discussion was sought from the scientists present in Frascati on the current outline of these mission themes and the scientific opportunities they entail, including potential requirements stemming from maximizing scientific return. At the same time, the contents and development process of the Science White Paper was presented in order to allow a transparent and open interaction with all relevant communities.

The following discussion notes capture a selection of the points raised during the open forum discussions.

Extended duration mission to a cis-lunar habitat

Many comments indicated the importance of knowing cis-lunar infrastructure capabilities for assessing utilization scenarios:

- Reusable lander allows global access, if you have an outpost/habitat could use local resources to make it a fueling station.
- Testing of long-duration hardware where you have a human to fix it. Real time observations of the lunar surface from the habitat.
- Gateway for accessing the surface. Crew operated robotics. Tele-robotics feeds forward to Mars.
- High-speed operations of rover. Less than 0.5 second latency is enabling.
- Need to make bandwidth. Habitat needs to have high throughput comm capability.
- Ability to move things around cislunar space. Telescope servicing. Can move assets from earth-Sun Lagrange to Moon L2 for servicing.
- Construction of large telescopes at L2. Cheaper? But big plus is you can fix it. Possibly design future telescopes so that they can use SEP to get to L2 where they can be serviced, then returned to their ideal location.
- Keeping farside radio quiet. Is it being thought about? Orbital assets will leak low frequency noise. L2 Habitat needs to have a noise threshold. Faraday cages, etc.? Need an international agreement.
- Certain radio astronomy might need to be done before you get too much noise?
- Fundamental physics due to longer distances.
- In-situ analysis for astrobiology.
- Swap out experiments. Witness plates. Stardust. Astrobiology research

Comments on cis-lunar infrastructure for sample return:

- Sample return? Cryogenic storage on the habitat.
- Bring back larger samples if you only have to get it to habitat.
- Mars sample return. Samples come back to habitat. Practice with lunar samples. Develop a facility at L2.

Comments on location of human cis-lunar activity:

- Orion at L2 for human assisted sample return.
- L2 has better comm coverage to surface and to Earth. More attractive than DRO.
- L3 or L4 visiting for mini moons.

Comments on the cis-lunar habitat as an observatory:

- Earth climate: full disk observations of Earth over a range of phases.
- Habitat could be an observatory. E.g. look at lunar flashes. Get impact rate.
- Neutrino detector. Detector is on the habitat.
- Lunar exosphere observations.

Human exploration of a Near-Earth Asteroid in cis-lunar space

Major comments indicated the importance of the selection of the NEA object for assessing science opportunities:

- Need to clarify that different types of asteroids give you different science.

Comments on sample selection and sample return from NEA:

- Sample return provides key science.
- Use the meteorite collection to help with sample choice.
- Analyses need to be very precise and are very hard to do robotically or remotely. Best science comes from earth labs. E.g. isotopic analysis, thin section.
- Have small s/c at L2 that takes samples from near-misses. i.e. when an asteroid comes by, one of these s/c can then chase it down and collect a sample.
- Multiple drilling sites. Exposure ages at different depths. Exposure age would have to be determined back on Earth.
- More mass coming back could enable chronology and spatial distribution. But preselection is important.
- Drilling depths >2m required to have pristine samples (no influence from radiation).
- Preservation of depth profile of the sample possible with humans.
- Human selection of samples most beneficial due to information from previous samples available on Earth.

Other comments:

- Testing surface charging/plasma models.
- Information on structure/stratigraphy.
- Placing instruments on the surface. E.g. seismometer. Hard to couple, possibly enabled by humans. Active experiment with triggered seismic event could be possible.
- Learning how to extract resources.
- Lunar disposal, learn about impact processes.
- Practice asteroid deflection techniques.

Human lunar surface exploration

Major comments indicated importance of landing site selection for assessing science opportunities:

- Studying swirls might provide information on shielding
- Ability to explore pits.
- We've never been to the farside. Never been to polar.

Comments on surface mobility:

- Efficient mobility is key.
- Even a trip with limited mobility can do fundamental science.
- A single lander with a rover can do a lot.
- Don't start with a habitation rover. But what about radiation.

Other comments on benefit of human explorers:

- Finding the unusual. E.g. "That rock".
- Strategic sample selection by human geologist: amount of samples, type of samples, high-grading of samples.
- Good science you can do even before having the capability of the DRM.
- Focus on the remaining big science questions. Then show what capability is needed to answer them.
- Link the science to a capability. If you want to do X science, you need X capability.
- Importance of EVAs.
- Human-robotic interaction beneficial or even required for volatile sampling.
- Deployment of surface experiments by crew.
- Learning how to extract resources.
- Science opportunities within the constraints of the DRM need to be understood. Capability-enabled science → what can you do rather than specific instrument technology.
- Learn about scale of "contamination" by human activity from early missions.
- Learn about human physiology under reduced gravity (feed forward for Mars).